



*Atoms for Peace and Development*

الوكالة الدولية للطاقة الذرية  
国际原子能机构  
International Atomic Energy Agency  
Agence internationale de l'énergie atomique  
Международное агентство по атомной энергии  
Organismo Internacional de Energía Atómica

Vienna International Centre, PO Box 100, 1400 Vienna, Austria  
Phone: (+43 1) 2600 • Fax: (+43 1) 26007  
Email: [Official.Mail@iaea.org](mailto:Official.Mail@iaea.org) • Internet: <https://www.iaea.org>

In reply please refer to: **EVT1805403**  
Dial directly to extension: (+43 1) 2600-28231

The Secretariat of the International Atomic Energy Agency (IAEA) presents its compliments to the IAEA's Member States and has the honour to draw their attention to the **Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications** (hereinafter referred to as "event") to be held at the IAEA's Headquarters in Vienna, Austria, from **9 to 12 September 2019**.

The purpose of the event is to assess the current status and potential applications of muon radiography for non-destructive testing, and to elaborate an action plan to develop and facilitate its utilization.

The event will be held in English.

Member States are invited to designate one or more participants for this event. Member States are strongly encouraged to identify suitable women participants.

The IAEA is generally not in a position to bear the travel and other costs of participants in the event. The IAEA has, however, limited funds at its disposal to help meet the cost of attendance of certain participants. Upon specific request, such assistance may be offered to normally one participant per country, provided that, in the IAEA's view, the participant will make an important contribution to the event. The application for financial support should be made at the time of designating the participants using the attached Grant Application Form (Form C).

It should be noted that compensation is not payable by the IAEA for any damage to or loss of personal property. The IAEA also does not provide health insurance coverage for participants in IAEA events. Arrangements for private insurance coverage on an individual basis should therefore be made. The IAEA will, however, provide insurance coverage for accidents and illnesses that clearly result from any work performed for the IAEA.

Designations should be submitted to the IAEA through the competent national authority (Ministry of Foreign Affairs, Permanent Mission to the IAEA or National Atomic Energy Authority) not later than **25 June 2019** using the attached Participation Form (Form A). Completed and authorized Participation Forms should be sent either by email to: [Official.Mail@iaea.org](mailto:Official.Mail@iaea.org) or by fax to: +43 1 26007 (no hard copies needed). Copies should be sent by email to the Scientific Secretary of the event, Mr Francois Foulon, Division of Physical and Chemical Sciences, Department of Nuclear Sciences and Applications (Email: [F.Foulon@iaea.org](mailto:F.Foulon@iaea.org)), and to the Administrative Secretary, Ms Marion Linter (Email: [M.Linter@iaea.org](mailto:M.Linter@iaea.org)). The Scientific Secretary of the event will liaise with the participants directly concerning further arrangements, including travel details, as appropriate, once official designations have been received.

Should Governments wish, in addition, to appoint one or more observers to assist and advise the designated participants, they are kindly requested to inform the IAEA of the names and contact details of any such observers by the above date. In accordance with the established rules, Governments are expected to bear the cost of attendance of any observers they may send to IAEA events. Compensation is not payable by the IAEA for any damage to or loss of observers' personal property or for illness, injury or death occurring while travelling to or in connection with their attendance at IAEA events.

The Secretariat of the International Atomic Energy Agency avails itself of this opportunity to assure the IAEA's Member States of its highest consideration.



2019-04-11

Enclosures:      Information Sheet  
                         Participation Form (Form A)  
                         Form for Submission of a Paper (Form B)  
                         Grant Application Form (Form C)



**IAEA**

International Atomic Energy Agency

*Atoms for Peace and Development*

# **Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications**

**IAEA Headquarters  
Vienna, Austria**

**9–12 September 2019**

**Ref. No.: EVT1805403**

## **Information Sheet**

### **Background**

Non-destructive techniques, such as X-ray and gamma radiography, have been widely used in various metal and processing industries to improve product quality and assess the safety and integrity of structures. Their technical, economic and environmental benefits have been well demonstrated and recognized in many industrial sectors. These techniques are based on radiation generators or sealed sources that are used in both laboratory environments and industry.

Muon radiography, which is based on cosmic rays, may provide alternative or complementary solutions without the need for a man-made source and thus without regulatory constraints. Indeed, cosmic rays generated through the interaction of high-energy particles (mainly protons) in the earth's upper atmosphere produce copious numbers of pi-mesons, some of which decay into muons. Muons have properties similar to electrons but have a much larger mass. They interact mainly through weak and Coulomb interactions so that they can reach the surface of the earth. While other high-energy particles (protons, electrons and gamma rays) are filtered out by the shielding of the atmosphere, muons represent 98% of terrestrial cosmic rays at ground level.

The flux of muons at the ground level is about 10 000 per minute per square metre and the mean free path of muons is substantial. As a result, some muons can penetrate hundreds of metres of rock. Thus, muons can be used as a highly penetrating non-destructive probe. The technique of muon transmission/attenuation can be best applied to static situations where days of exposure time are

available, and detectors with large areas (square metres) can be used. The technique has been used for applications ranging from archaeological studies, volcanology and geological imaging, and is known as muon transmission radiography or muon transmission tomography.

Another tomographic technique is also under development — muon scattering tomography. This technique involves measuring both the incident and the transmitted muon and determining the amount of scattering the muon has undergone to ascertain the thickness of the material the muon has traversed.

In muon transmission radiography, the statistical precision is proportional to  $\lambda/\sqrt{N}$ , where  $\lambda$  is the stopping range of muons ( $\sim 1000$  g/cm<sup>2</sup> at the earth's surface) and  $N$  is the muon fluence (integrated flux) through a resolution element of size  $l$ . In muon scattering tomography, the precision is proportional to  $l/\sqrt{2N}$ .

Both of these techniques may be exploited in numerous applications ranging from geology, industry and civil engineering to security and safeguards. Recently this field of research attracted attention from various groups around the world, and the number of publications dealing with muon radiography or muon tomography has increased considerably in the last few years.

However, since muon radiography is an emerging technique, there are still open questions and scientific challenges to be addressed.

## Objectives

The event aims to serve as a forum for participants to discuss and share recent advances in muon radiography, as well as to evaluate the status and current trends regarding practical applications of muon radiography, both in developed and developing IAEA Member States.

The event will provide an opportunity to bring together the stakeholders involved in this activity, including those engaged in the development of muon radiography techniques and associated instrumentation, as well as their potential end users.

Since the IAEA is playing an important role in the dissemination of knowledge and transfer of relevant technologies, the event will also be used to develop strategies to facilitate the technical advancement of these techniques and their applications.

## Target Audience

The event is intended for individuals from Member States that are directly involved in the development or utilization of muon radiography techniques.

## **Topics**

The following topics will be discussed:

- Recent development in detection systems, data acquisition and data analysis in muon radiography techniques;
- Experience and lessons learned from the development and utilization of muon radiography techniques;
- Identification of challenges to be overcome to facilitate and widen applications of muon radiography techniques; and
- Development of strategies to further enhance collaboration in the advancement of muon radiography techniques and their promotion among potential users, both in developed and developing Member States.

## **Expected Outputs**

The expected output is an event report based on the abstracts and presentations of the participants and on subsequent round-table discussions. The report will:

- Provide an overview of the recent development in detection systems, data acquisition and data analysis in muon radiography techniques;
- Gather the experience and lessons learned from the development and utilization of muon radiography techniques by practitioners and end users; and
- Identify opportunities for Member States to access/utilize muon radiography techniques as a complementary non-destructive testing technique.

## **Structure**

The meeting will consist of plenary sessions and round-table discussions

Time will be allocated for the participants to present Member State experiences and needs.

## **Working Language(s)**

English.

## Participation

All persons wishing to participate in the event have to be designated by an IAEA Member State or should be members of organizations that have been invited to attend.

In order to be designated by an IAEA Member State, participants are requested to send the **Participation Form (Form A)** to their competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA or National Atomic Energy Authority) for onward transmission to the IAEA by **25 June 2019**. Participants who are members of an organization invited to attend are requested to send the Participation Form (Form A) through their organization to the IAEA by above deadline.

In addition, persons wishing to participate are invited to submit a one-page abstract addressing one or more of the topics listed above. The Scientific Secretaries will assess eligibility based on the contents of the abstract.

## **Selected participants will be informed in due course on the procedures to be followed with regard to administrative and financial matters. Expenditures and Grants**

No registration fee is charged to participants.

The IAEA is generally not in a position to bear the travel and other costs of participants in the event. The IAEA has, however, limited funds at its disposal to help meet the cost of attendance of certain participants. Upon specific request, such assistance may be offered to normally one participant per country, provided that, in the IAEA's view, the participant will make an important contribution to the event.

The application for financial support should be made using the **Grant Application Form (Form C)** which has to be stamped, signed and submitted by the competent national authority to the IAEA together with the **Participation Form (Form A)** by **25 June 2019**.

## Venue

The event will be held at the Vienna International Centre (VIC), where the IAEA's Headquarters are located. Participants must make their own travel and accommodation arrangements.

General information on the VIC and other practical details, such as a list of hotels offering a reduced rate for IAEA participants, are listed on the following IAEA web page:  
<http://www-pub.iaea.org/iaeaevents/GeneralInfo/Guide/VIC>.

Participants are advised to arrive at Checkpoint 1/Gate 1 of the VIC one hour before the start of the event on the first day in order to allow for timely registration. Participants will need to present an official photo identification document in order to be admitted to the VIC premises.

## Visas

Participants who require a visa to enter Austria should submit the necessary application to the nearest diplomatic or consular representative of Austria at least four weeks before they travel to Austria. Since Austria is a Schengen State, persons requiring a visa will have to apply for a Schengen visa. In States where Austria has no diplomatic mission, visas can be obtained from the consular authority of a Schengen Partner State representing Austria in the country in question.

## IAEA Contacts

### Scientific Secretaries:

#### **Mr Francois Foulon**

Division of Physical and Chemical Sciences  
Department of Nuclear Sciences and Applications  
International Atomic Energy Agency  
Vienna International Centre  
PO Box 100  
1400 VIENNA  
AUSTRIA

Tel.: +43 1 2600 28231

Fax: +43 1 26007

Email: [F.Foulon@iaea.org](mailto:F.Foulon@iaea.org)

#### **Mr Patrick Dominique M. Brisset**

Division of Physical and Chemical Sciences  
Department of Nuclear Sciences and Applications  
International Atomic Energy Agency  
Vienna International Centre  
PO Box 100  
1400 VIENNA  
AUSTRIA

Tel.: +43 1 2600 21745/21747

Fax: +43 1 26007

Email: [P.Brisset@iaea.org](mailto:P.Brisset@iaea.org)

**Administrative Secretary:**

**Ms Marion Linter**

Division of Physical and Chemical Sciences  
Department of Nuclear Sciences and Applications  
International Atomic Energy Agency  
Vienna International Centre  
PO Box 100  
1400 VIENNA  
AUSTRIA

Tel.: +43 1 2600 25119

Fax: +43 1 26007

Email: [M.Linter@iaea.org](mailto:M.Linter@iaea.org)

Subsequent correspondence on scientific matters should be sent to the Scientific Secretaries and correspondence on other matters related to the event to the Administrative Secretary.

# Participation Form

## Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications

IAEA Headquarters, Vienna, Austria

9–12 September 2019

To be completed by the participant and sent to the competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA, or National Atomic Energy Authority) of his/her country for subsequent transmission to the International Atomic Energy Agency (IAEA) either by email to: [Official.Mail@iaea.org](mailto:Official.Mail@iaea.org) or by fax to: +43 1 26007 (no hard copies needed). Please also send a copy by email to the Scientific Secretary [F.Foulon@iaea.org](mailto:F.Foulon@iaea.org) and to the Administrative Secretary [M.Linter@iaea.org](mailto:M.Linter@iaea.org).

Please attach a passport copy or other document of identification (ID).

Participants who are members of an invited organization can submit this form to their organization for subsequent transmission to the IAEA.

**Deadline for receipt by IAEA through official channels: 25 June 2019**

Family name(s): (same as in passport)	First name(s): (same as in passport)	Mr/Ms
Institution:		
Full address:		
Tel. (Fax):		
Email:		
Nationality:	Representing following Member State/non-Member State/entity or invited organization:	
If/as applicable:		
Do you intend to submit a paper?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Would you prefer to present your paper as a poster?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Title:		





# Form for Submission of a Paper

## Technical Meeting on Non-destructive Testing Using Muon Radiography: Present Status and Emerging Applications

IAEA Headquarters, Vienna, Austria

9–12 September 2019

To be completed by the participant and sent to the competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA, or National Atomic Energy Authority) of his/her country for subsequent transmission to the International Atomic Energy Agency (IAEA) either by email to: [Official.Mail@iaea.org](mailto:Official.Mail@iaea.org) or by fax to: +43 1 26007 (no hard copies needed). Please also send a copy by email to the Scientific Secretary [F.Foulon@iaea.org](mailto:F.Foulon@iaea.org) and to the Administrative Secretary [M.Linter@iaea.org](mailto:M.Linter@iaea.org).

Participants who are members of an invited organization can submit this form to their organization for subsequent transmission to the IAEA.

**Deadline for receipt by IAEA through official channels: 25 June 2019**

Title of the paper:		
If applicable: Abstract ID in IAEA-INDICO:		
Family name(s) and first name(s) of all author(s) (same as in passport(s)):	Scientific establishment(s) in which the work has been carried out	City/Country
1.		
2.		
3.		
Family name(s) and first name(s) of author presenting the paper (same as in passport):	Mr/Ms:	
Mailing address:		
Tel. (Fax):		
Email:		

I hereby agree to assign to the International Atomic Energy Agency (IAEA):

- the copyright; or
- the non-exclusive, worldwide, free-of-charge licence (this option is only for those authors whose parent institution does not allow them to transfer the copyright for work carried out in that institution) granting the IAEA world rights for the use of the aforementioned material in this and any future editions of the publication, in all languages, and in all formats available now, or to be developed in the future (digital formats, hard copy etc.).

**Please note:** If granting the licence mentioned above, please supply any copyright acknowledgement text required.

Furthermore, I herewith declare:

- that the material submitted to the IAEA is original, except for such excerpts from copyrighted works as may be included with the permission of the copyright holders thereof, has been written by the stated authors, has not been published before, and is not under consideration for publication by another entity;
- that any permissions and rights to publish required for third-party content, including but not limited to figures and tables, have been obtained, that all published material is correctly referenced; and
- that the material submitted to the IAEA does not contain any libellous or other unlawful statements and does not contain any materials that violate any personal or proprietary rights of any person or entity.

**Date:**

**Signature of main author:**

